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RHYTHM IN HANDWRITING

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INTRODUCTION

The problem in this study is to discover the amount of rhythm that exists in the handwriting of school children and the relation that rhythm bears to age. The importance of this problem was impressed upon the investigator by an experimental study made in the University of Chicago laboratory for the purpose of extending the earlier experiments of Dr. Freeman.[1] The results of this preliminary study seemed to warrant certain tentative conclusions with regard to the relation of rhythm to the problem of teaching handwriting. Since rhythm seemed to be related to age, there must be an age of maximum rhythmic development. This age is probably the time at which intensive writing drills should be introduced into the training of children. Writing systems must be adapted to the natural rhythmic development of children else they have no claim upon educational practice.

In addition to the problem of discovering the part that rhythm plays in the child's development in writing, this study was undertaken to discover the amount of arm movement employed by children in their writing, and its relation to age. If arm movement is valuable and is related to age, then there must be an age at which intensive arm-movement drills will net the best results. On the other hand, if rhythm is the important element and if arm movement is not related to rhythm, then arm-movement drills may be practically a total loss so far as their effect upon skill in writing is concerned. This study undertakes to establish rather conclusively just the relations that exist between these various factors and the bearing that the established relations should have upon educational practice in teaching handwriting.

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[1] *Yale Psychological Studies*, New Series, II, No. 1. *Psychological Monographs*, XVII, 1914.

SOURCES OF SECURING RECORDS

In order to determine what influence special training may have upon the development of arm movement and upon the development of rhythmic habit, records were secured from schools that are representative of different types of effort in this respect. Schools in which special movement drills have been emphasized for a number of years, and schools in which only ordinary copy-book practice has been employed for a considerable period of time were studied.

1. Records were secured from the following schools: one of the ward schools of Kansas City, Kansas, which has used the Ransomalian writing system for a number of years; two ward schools of Topeka, Kansas, in which the Palmer system has been used for a number of years; Winfield, Kansas, which has used the state copy-book system for several years; Mattoon, Illinois, which has used the Berry copy-book system for several years; two ward schools of Grand Rapids, Michigan, in which the Palmer system has been used for a number of years.

2. Records were secured in all of these schools from the second to the eighth grades inclusive and from the ages of seven to fourteen inclusive.

3. The securing of these records under normal conditions was made possible only by the courtesy and earnest co-operation of the superintendents, principals, and teachers of the schools named above, therefore credit for the success of the study is in a large measure due them. For invaluable assistance in securing normal records from the younger children and for much painstaking clerical help in the measuring of the records, I am indebted to Mrs. Nutt.

APPARATUS AND METHOD OF TAKING A RECORD

The purpose of the apparatus was to secure a specimen of the writer's handwriting, a record of the amount of arm movement employed in writing the copy, and a record of the movement of the writer's pencil so spread out from left to right upon a strip of paper moving at known speed as to make possible the measuring of the time taken for the writing of each stroke. The mechanism of the apparatus afforded a means of measuring speed by providing underneath the sheet of paper on which the subject wrote a typewriter-ribbon belt moving from right to left and directly beneath the ribbon a moving strip of paper on which a traced record was received. Thus, when the writer wrote upon the stationary sheet of paper, the path of the pencil-point was made upon the moving strip of paper. The speed of the strip of paper was recorded by tracing on it the path of an electrically driven vibrating pen. This path is called the time line.

The arm movement was recorded by attaching a system of levers to the back of the hand, by means of an elastic band about the hand, through which the movement of the hand was transmitted to a pen writing on another sheet of paper. This mechanism was kept so accurately adjusted that an almost perfect reproduction of the written copy was secured if the writer was using no finger movement.

MEASUREMENT OF THE RECORDS

1. The quality of the writing specimens was graded according to both the Freeman and the Ayres scales. Both grades were recorded and indicated by the letters *F* and *A* respectively.

2. The arm movement records were graded by means of a scale which was worked out from the total number of specimens to be graded. The scale grades from zero to five as shown by the reproduction of the scale given in Fig. 1.

3. The time taken in the making of each stroke of the word "bravely," which was the copy used throughout the study, was determined by superimposing a traced copy of the word over the record on the moving strip of paper, which was made through the typewriter ribbon. By this procedure it was possible to bring the path of the pencil under the written copy. By moving the belt forward from right to left each point in the recorded path could be made to coincide with the corresponding point made by the pencil at the same time in the written word. The procedure was to set the moving strip in such a position that the traced record fell under the beginning of a stroke in a writing, and then moving it along until it reached the end of the stroke, to count the number of vibrations in the time line which passed a fixed point. Each vibration on the time line represented 1/35 second, and the time could be calculated in 1/100 second.

4. The degree of rhythm manifested in each record was graded by weighing three considerations, namely, the largest number of strokes made in the same length of time, the number of groups into which the duration of the strokes fell, called the time groups, and the range of the time groups. The largest number of strokes made in the same length of time was found to range from 4 to 22, a range of 19 steps. The grades given for the largest number of strokes therefore range from 1 to 19. The number of time groups for making all the strokes ranged from 11 down to 2, a range of 10 steps. The grades for the number of time groups therefore range from 1

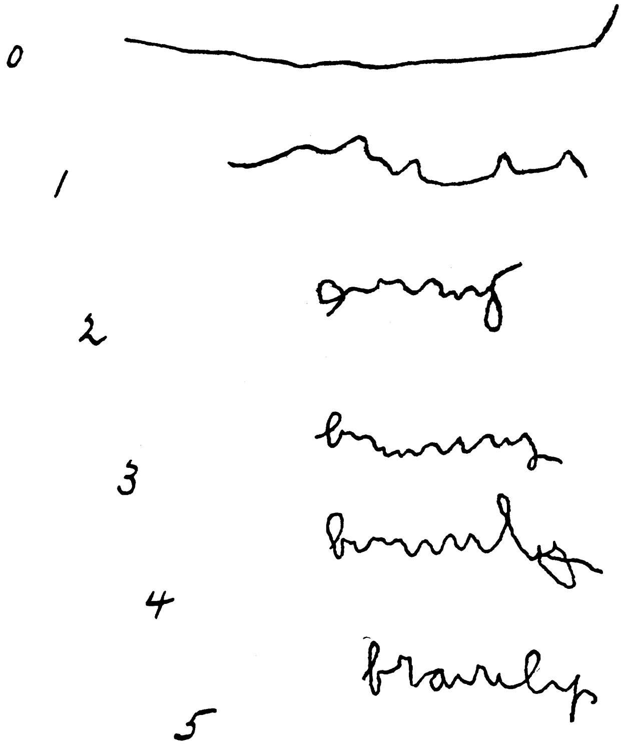

FIG. 1.—Arm movement scale. Each specimen on the scale represents the tracing of the arm movement of some individual in writing the word "bravely." The first specimen, 0, represents no arm movement in forming the letters. The last specimen, 5, represents almost complete arm movement.

to 10. The range in difference of time between the shortest and the longest time for making a stroke that was employed by the respective writers was found to be from 10/100 second to 180/100, a range of 18 steps, since the time groups were each 10/100 second in range. Therefore the grades for the range of time groups range from 1 to 18. The total grade for rhythm was found by multiplying together the respective grades for the three items just given.

5. The average time per stroke was taken as the record for speed.

TABULATION OF RESULTS

The grades in rhythm, quality, and arm movement, the length of time for each stroke and the length of the line in each stroke of each letter written, and the speed for each individual were recorded by ages and by systems to be used as the source material from which all correlations were worked out. A sample sheet from Table I shows individual cases.

The significance of the results can be seen in a series of tables which are so constructed as to bring out certain relationships. The principle on which the tables are constructed is the same in all, and may be made clear by commenting on Table II. In this table each number represents a group of individuals. These individuals are classified and placed in the table on the basis of two sets of facts, age and the score in arm movement. All the pupils in a given horizontal row are of the same age, but they are distributed along the row according to their arm-movement grade. Similarly, all those getting a particular grade in arm movement are placed in a given vertical column, but they are distributed within this column according to age. It is clear that if the amount of arm movement increases as the child grows older the numbers will group themselves with greater or less closeness about a diagonal line from upper left to lower right. It is evident that this is true in Table II. There are practically no young children who use a large amount of arm movement, and scarcely any of the older ones use no arm movement. The other tables are to be interpreted in the same manner. All ages have been tabulated in each of the tables from four to eight inclusive, but only one age is given from each here as an illustration, since they are typical of all ages.

TABLE I

Individual cases: time T, in hundredths of a second; length of line L, in millimeters; average time per stroke, Sp (speed); arm movement, A.M.; Quality, Qual. F (Freeman), Qual. A (Ayres); Rhythm, Rthm; School systems, A, B, C, D, E.

	SYSTEM A								SYSTEM B			
	AGE SEVEN								AGE SEVEN			
	T	L	T	L	T	L	T	L	T	L	T	L
b........	64	18	17	19.2	118	23	44	18	24	6	164	14
	54	9	24	17	71	20	36	14	34	9	42	11.5
	25	6	61	7	51	9	39	7	19	4.3	16	10
	21	3	26	4	22	3	14	2	13	1	18	4.1
r........	28	6	83	6	32	7	20	8	15	4.3	14	7.4
	29	9	74	4.8	24	4.2	52	6.5	20	1	30	7.3
	25	6.5	54	4.5	64	7.3	31	10	9	2.4	18	7.8
a........	110	13.5	102	10.5	81	13.5	32	16	23	5	22	11
	13	12	86	8.5	50	11	29	11	40	4.1	13	10.3
	22	11	70	6	25	8.5	25	10.6	32	3.2	26	6
	27	7.5	43	4	34	8	43	7.5	22	2.3	28	4.1
v........	34	13.5	82	10	63	10.5	8	12	39	6	24	7.5
	33	5.9	71	11.5	38	8	46	7	31	4	22	7.6
	25	8.1	54	5.5	42	10.5	37	9	28	5.1	14	7
	26	2	65	3	17	3	22	4	24	1.4	9	4
e........	12	7	38	5.3	81	6	29	8.3	18	3.7	24	7.3
	50	11	69	4.5	28	7	33	7.2	31	7	23	9
l........	81	23	75	13.5	96	27	8	19	41	12.4	42	16
	54	16	61	11	30	21	30	16	22	12	13	13
y........	67	11	64	5	34	10	16	9	8	3	23	7
	24	6	32	4	20	7	23	5.6	7	2.5	9	6.1
	20	10	40	6	37	11	12	8	15	5	12	7
	24	16	25	14.4	45	18	34	18.5	19	11	16	17.4
	44	21	111	20	76	23	38	25	25	13	24	22.5
Sp.......	38		59		49		28		22		26	
A.M.....	1		0		1		1		1		5	
Qual. F..	27		21		18		20		15		8	
Qual. A..	70		80		40		60		30		20	
Rthm....	320		54		36		336		525		108	

INTERPRETATION OF RESULTS

1. *The relation of arm movement to age.*—Table II shows quite clearly that arm movement and age are closely correlated. Grade 1 on the scale indicates that the arm moves a very little in the

direction of forming the letters. Very few of the younger children, ages seven to nine, make a grade above 1 in arm movement, while a considerable number of the older children make a grade of 2 and above. This bunching of the younger children around the lower end of the scale and the corresponding bunching of the older children around the upper end shows that age is an important condition in the development of arm movement.

TABLE II

RELATION OF ARM MOVEMENT TO AGE

Age	Arm-Movement Grade					
	0	1	2	3	4	5
7	10	21	2	....	....	1
8	10	19	4	....	....	....
9	3	14	5	7	1	....
10	2	20	4	3	1	2
11	6	14	8	2	5	1
12	....	11	12	7	1	2
13	1	14	10	6	5	1
14	1	16	10	4	4	3

The tabulation of the arm-movement grades by systems, which is not shown here, brings out the fact that much the same characteristic grouping of cases exists in each system. None of the systems develops any appreciable degree of arm movement in the younger children. The systems in which the arm-movement drills were emphasized by the teachers, but in which no special supervisor was employed, developed practically the same amount of arm movement in the children from ages ten to fourteen as was developed by the copy-book systems. The system in which the special supervisor was employed developed a somewhat greater degree of arm movement in the nine-year-old children and a greater amount of movement in the upper ages.

2. *The relation of age to rhythm.*—Table III shows that age and rhythm are in close correlation. The distinct sweep of cases along the diagonal downward from left to right is clear evidence of the high degree of correlation between age and rhythm.

TABLE III

CORRELATION OF RHYTHM TO AGE

Rhythm	Age							
	7	8	9	10	11	12	13	14
4– 159.....	14	5	3	....	1	....	1	....
160– 313.....	5	3	....	1	1	....	....	....
314– 467.....	8	1	3	....	....	1	1	....
468– 621.....	3	3	6	3	4	1	....	1
622– 775.....	3	6	3	5	1	....	....	2
776– 929.....	1	2	....	4	2	1	1	2
930–1,083.....	....	4	2	1	2	4	....	2
1,084–1,237.....	....	....	2	5	2	2	6	....
1,238–1,391.....	....	3	3	5	....	2	2	5
1,392–1,545.....	....	4	4	4	8	....	6	6
1,546–1,698.....	....	....	1	3	3	5	1	1
1,699–1,853.....	....	1	....	1	4	6	3	6
1,854–2,007.....	....	....	2	....	4	3	4	5
2,008–2,161.....	....	....	1	....	3	2	4	3
2,162–2,315.....	....	....	1	....	....	3	1	1
2,316–2,469.....	....	....	1	....	....	2	4	1
2,470–2,663.....	....	....	....	....	....	....	1	2
2,664–2,777.....	....	....	....	....	....	....	....	....
2,778–2,931.....	....	....	....	....	....	1	1	....
2,932–3,085.....	....	....	....	....	....	....	1	....
3,086–3,240.....	....	....	....	....	....	....	....	1

3. *The relation of rhythm to arm movement.*—Table IV shows that there is no correlation between rhythm and arm movement. The cases are too evenly distributed at each age to show correlation.

TABLE IV

CORRELATION OF RHYTHM TO ARM MOVEMENT

Rhythm	Age Seven: Arm Movement					
	0	1	2	3	4	5
4– 159..............	4	8	1	....	....	1
160– 313..............	3	2	....	....	....	....
314– 467..............	2	6	....	....	....	....
468– 621..............	1	2	....	....	....	....
622– 775..............	1	1	1	....	....	....
776– 929..............	....	1	....	....	....	....
930–1,083..............	....	....	....	....	....	....
1,084–1,237 to 3,086–3,240.	....	....	....	....	....	....

4. *The relation of arm movement to quality.*—Table V shows such a general distribution of cases at each age and according to the grades assigned by both scales employed that no appreciable correlation exists between arm movement and quality.

TABLE V

RELATION OF ARM MOVEMENT TO QUALITY, FREEMAN'S SCALE

Quality	Age Seven: Arm Movement					
	0	1	2	3	4	5
6–10	5	5	1	....	....	1
11–15	1	7	1	....	....	....
16–20	2	8	....	....	....	....
21–25	1	....	....	....	....	....
26–30	....	1	....	....	....	....

5. *The relation of rhythm to quality.*—Table VI shows the same sort of general distribution of cases as is seen in Table V, so that the same conclusion is reached that there is no correlation between rhythm, in the sense in which it is here used, and quality.

TABLE VI

RELATION OF RHYTHM TO QUALITY, FREEMAN'S SCALE

Rhythm	Age Seven: Quality Grade				
	6–10	11–15	16–20	21–25	26–30
4– 159	6	3	4	1	....
160– 313	2	1	2	....	1
314– 467	2	3	2	....	....
468– 621	1	1	1	....	....
622– 775	2	....	1	....	....
776– 929	....	1	....	....	....
930–1,083 to 3,086–3,240	....	....	....	....	....

6. *The relation of speed to arm movement.*—Table VII presents again such a general distribution of the cases that no correlation is shown.

TABLE VII

RELATION OF SPEED TO ARM MOVEMENT

Arm Movement	Age Seven: Speed (Average Time per Stroke, Hundredths of a Second)					
	64–75	53–63	42–52	31–41	20–30	8–19
0	1	1	4	3	2	....
1	2	1	5	5	7	....
2	....	1	....	....	1	....
3	....	....	....	....	....	....
4	....	....	....	....	....	....
5	....	....	....	....	....	....

7. *The relation of speed to rhythm.*—Table VIII shows a distinct sweep of cases at each age along the diagonal downward so that a high degree of correlation of speed to rhythm is shown.

TABLE VIII

RELATION OF SPEED TO RHYTHM

Rhythm	Age Seven: Speed (Average Time per Stroke, Hundredths of a Second)					
	64–75	53–63	42–52	31–41	20–30	8–19
4–159	3	2	7	1	1	....
160–313	....	....	3	2	....	....
314–467	....	....	....	5	3	....
468–621	....	....	....	....	3	....
622–775	....	....	....	....	3	....
776–929 to 3,086–3,240	....	....	....	....	1	....

PSYCHOLOGICAL AND PEDAGOGICAL INFERENCES

1. The fact that arm movement is so closely correlated to age seems to justify the conclusion that children naturally use finger movement first in their writing. Training in special arm-movement drills does not change the nervous system of the child and does not change the character of the natural co-ordinations. From age ten on a considerable number of the cases naturally adopted arm movement and developed a considerable degree of skill as compared to those who had been given special training in arm movement. Also from age ten on a good many children neither naturally nor by training attained a grade in arm movement above 1. Furthermore, arm movement is not correlated to quality, rhythm, or speed. In the light of these three facts, the question naturally arises, is arm movement worth while? The answer seems obvious enough so far as its value goes in promoting quality, speed, and rhythm. The fact that a good many children naturally adopt arm movement as they become more mature seems to argue that it has other values than those just noted. If this is true, what are these values, and are they values that are important enough to justify an intense effort to attain them on the part of those who do not naturally adopt arm movement? Until this question has been scientifically answered, the conclusion seems warranted that arm movement

should be left to individual selection and development. If, however, school people believe that the benefit of the doubt should be on the other side and therefore wish to continue the intensive use of arm-movement drills in the teaching of writing, then the conclusion is that these drills should not be given in general before the child is ten years old or above. Exception might be made in those cases of younger children who of their own accord naturally adopt the arm movement. On the same ground of natural selection children who naturally do not select arm movement as they mature might be exempted from the arm-movement drills.

2. Rhythm is correlated to age to so high a degree that it must play a large part in the development of any kind of skill that employs co-ordinations of hand and arm. Rhythm and speed are so closely correlated that the logical conclusion seems to be that speed cannot be forced ahead of the natural development of rhythm. The results do not show, however, that speed may not be the primary factor. Hence the desire for speed and intensive efforts to secure it may bring about the rhythmic habit as the means of securing the desired result. Whichever may be the primary factor, the significance of their correlation for educational practice in the teaching of writing remains the same, namely, that writing exercises that are intended to secure speed, and the standards of attainment in speed, must be carefully adapted to age as the dominant condition in rhythm.

Although age is the chief condition in the development of rhythm and speed, the relation of these factors to age by systems seems to indicate that the type of training given may have some effect upon their development. System C, for instance, seems to develop more rhythm than any of the others, while system B seems to develop more speed than any other system. Just what the elements in each of these systems are that may have produced these varying degrees of rhythm and speed is not shown by this study. There are no norms or standards for rhythm and speed, hence it is impossible to say what the degree of correlation is between these two factors that insures the best results in handwriting. System C may be producing the normal degree of rhythmic habit at the expense of quality. System B may be securing too high a degree of speed or it may have the right relation of rhythm to speed. The significant point is that any system of training that is valid ought to be able to insure what habits it will develop and to insure that these habits are the fundamental ones at each stage of development. If the system cannot demonstrate itself on a truly scientific basis, its claim upon educational practice is open to serious question.

Rhythm is not correlated to quality, and since rhythm develops with age it will be likely to resist any kind of training that tends to break it up. If certain letters contain strokes that are abrupt in their junction with one another, or are abrupt in their junction with the first stroke of any successive letter, the dominance of the rhythmic habit will tend to cause the writer to slur over the difficulty. This fact presents a critical point in the problem, namely, how can rhythmic habit be employed in writing so as not to interfere with the securing of a desired degree of quality?

The difficulty of the problem is increased by the fact that speed tends to cause this same sort of slurring over the difficult junction of strokes. Speed is correlated to rhythm, hence the more the rhythmic habit matures the greater the natural development of speed; and the greater the development of both rhythm and speed the greater the tendency to slur over the difficulties in letter formation so that quality is sacrificed. This conclusion seems to be supported by the general observation of the writing habits of adults. Most adults employ writing under conditions that demand their maximum of speed. In order to meet the demand for speed they slur over the difficult places at the sacrifice of good letter formation, alignment, and spacing. This is true even in the case of adults who have been well trained in penmanship.

In the light of these considerations certain conclusions may be drawn.

1. Parallel standards of quality and speed should be worked out for each grade. These standards should be adapted to the reasonable demands that may be made upon pupils to use writing as a means for getting along well in their studies, and should take into account the different groups of rhythmic habit in each grade. That is to say, these parallel standards should be so graded and correlated that pupils will neither sacrifice speed to too great a degree for the

sake of quality nor sacrifice quality to too great an extent for the sake of speed, but that for each group of writers there shall be a balanced speed-quality standard of attainment which shall be strictly possible because of normal rhythmic habit and conceptual habit of form found in each group.

2. Written forms should be so analyzed as to discover the particular letters and parts of letters that tend to be slurred over when speed and rhythmic habit assert their dominance. These having been determined, special drills should be devised for each grade that will thoroughly develop the speed-quality standard adapted to each grade in the writing of these forms.

3. Attention should be given to the possibility of modifying the conventionality of these forms so as to utilize both rhythm and speed in securing the highest relative standard of quality in each grade.

4. Written work in the different grades should be reduced to the minimum and should be employed under conditions that will not make greater demands upon speed than are in keeping with the speed-quality standard adapted to each grade. This will mean little or no written work in connection with class recitations and individual preparation of lessons in the first three grades.

5. A period of intensive writing drill, for the purpose of securing the maximum speed-quality standard of attainment, should be provided for at the approximate age at which rhythmic habit reaches its maximum of development.

Certain investigations and experiments will be necessary in order to bring about the ends that the conclusions given above set up.

1. An experimental study should be made to determine the size of letters, the slant, the modifications of letters, and the methods of teaching that will utilize the rhythmic habit at every stage in securing the adopted speed-quality standard of attainment.

2. This study in rhythm should be extended to the upper ages of adolescence to discover the age at which rhythmic habit reaches its maximum development.

3. A thorough test should be made of the maximum speed-quality standard that may be attained by means of intensive writing

drills at this age. This test should determine the length of time necessary for the attaining of desired efficiency and the methods of instruction that are most effective.

4. An experimental study covering a period of four or five years should be conducted to determine the results that may be obtained by making the learning of written forms a part of the work in drawing during the first three years of school work. The first step in learning to make letters is drawing. The purpose of this study, therefore, should be to discover the stages of development in building up accurate concepts of the forms of the writing conventions and the time at which drawing skill becomes facile enough to be employed as writing.